

Linac Upgrade Note # 225

Explanation of Linac BPM Channels

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This note describes the way the BPM position signals are obtained in the Linac control system. The goal is for the control system to obtain an average and (an optional) sigma, as defined below, from each available BPM. This is accomplished through the BPMQ local application (LA) in the Linac local control station, node 62F.

The Beam Position Monitor (BPM) signals in the High-Energy Linac (HEL) are digitized through the Fermilab-designed 1-, 2- and 5-MHz Quick Digitizer (QD) VME ADC modules. (The intensity signals are digitized in the conventional way, through an SRM.) Each QD module is capable of digitizing four channels simultaneously at this frequency. Since there are 62 BPM position channels and only 40 201 MHz RF modules available at this time, only the 40 "most important" BPM readouts are available through the control system. ("Most important" means all the BPMs at the beginning and the end of the HEL and a few key BPMs in between.) The placement of the RF modules and the Quick Digitizers can be observed in the Diagnostics Room. The channels, their names and their meanings are summarized in Table 1. All BPM signals (position and intensity) are defined in the database, but only the ones specified in the Table are active.

For typical Linac beams (15 to 45 usec in duration), the QD provides from 15 to 45 samples (1-MHz QD) of the beam position during the beam pulse. The immediate goal is to provide a single, scalar value to the user for observation in the normal manner in the control system, e.g., through a parameter page. There are two ways to do this. The first way is to do nothing and allow the "center" digitized reading to become the reading for the channel. This is done through a data-access table "copy" entry. The other method is to enable the "Local Application" (LA) for this Quick Digitizer. The LA produces an average of the beam pulse position, as specified by the "FIRST" and "LAST" samples in the database parameters L:DmnFST and L:DmnLST, respectively. This is an average produced on a single beam pulse. The FIRST sample, measured with respect to the trigger time, approximately at $t=1950$ usec, is where the averaging begins and the LAST sample is where the averaging ends. If FIRST=LAST, then no averaging is done, and that sample is considered the "average." Typical values for FIRST and

LAST for a 1-MHz digitizer are 45 and 55, which would take the average on the ten samples around the T=2000 (TDATA) point. (For a 5-MHz digitizer, these would be 245 and 255). The averaging is turned on by exercising the ON property of the channel indicated in the Table 1. The LA performs the averaging for all four QD channels. The generic channels associated with the LA is listed in Table 2. The averaging is done only when we had a beam pulse; the most recent value is copied into the channels on pulses without beam.

A second option on this LA is to compute the standard deviation, or "sigma", on each pulse from the QD. Because it is necessary for the local control station to continue to run at 15 Hz, this option should be used sparingly. The sigma is calculated over the same range as the average. If FIRST-LAST, then sigma=0, by definition. If sigma shows the value -1, then either an arithmetic exception has been found or the sigma calculation is turned off. The sigma calculation is turned on by exercising the ON property of the channel indicated in Table 1.

For an average over 10 samples with no sigma calculation, this LA consumes approximately 2 milliseconds in the local station. Turning on the sigma calculation increases this marginally (to just under 2.5 ms).

In order to insure that the QD comes up with its registers in the correct configuration, two pseudo-channels are used. They are L:DqQDR1 and L:DqQDR2 for registers 1 and 2, respectively. The common value we expect for now for these channels will be 0x4C08 and 0x0200.

To change the selection of channels which are being digitized, it is necessary to: (1) change the RF cabling at the RF module, (2) change the signal cabling at the QD and (3) change the local database. It is not thought that this operation will happen very often.

Table 1, Local Application Parameters and BPM Readout for the HEL

QD		Database	Database Title	Description	Chan #	Binary Control
#	Ch					
0		D01FST	QD0LA FIRST SAMPLE	First sample position	62f:500	
		D01LST	QD0LA LAST SAMPLE	Last sample position	62f:501	
		D01MPH	BPM MEM POINTER	QD Memory pointer; All BPMs have this DmnMPx channel.	62f:340	
	0	D01BPH	QD0LA AVERAG ONOFF	Calc'd average for M0-S1	62f:502	ON/OFF AVG
	1	D01BPV	QD0LA AVERAG VERTI	Calc'd average for M0-S1	62f:503	
	2	D02BPH	QD0LA AVERAG HORIZ		62f:504	
	3	D02BPV	QD0LA AVERAG VERTI		62f:505	
	0	D01HSG	QD0LA SIGMA ONOFF		62f:506	ON/OFF SIGMA
	1	D01VSG	QD0LA SIGMA VERTIC		62f:507	
	2	D02HSG	QD0LA SIGMA HORIZO		62f:508	
	3	D02VSG	QD0LA SIGMA VERTIC		62f:509	
1		D03FST	QD1LA FIRST SAMPLE	First sample position	62f:510	
		D03LST	QD1LA LAST SAMPLE	Last sample position	62f:511	
		D03MPH	BPM MEM POINTER	QD Memory pointer	62f:344	
	0	D03BPH	QD1LA AVERAG ONOFF	Calc'd average for M0-S3	62f:512	ON/OFF AVG
	1	D03BPV	QD1LA AVERAG VERTI	Calc'd average for M0-S3	62f:513	
	2	D11BPH	QD1LA AVERAG HORIZ		62f:514	
	3	D11BPV	QD1LA AVERAG VERTI		62f:515	
	0	D03HSG	QD1LA SIGMA ONOFF		62f:516	ON/OFF SIGMA
	1	D03VSG	QD1LA SIGMA VERTIC		62f:517	
	2	D11HSG	QD1LA SIGMA HORIZO		62f:518	
	3	D11VSG	QD1LA SIGMA VERTIC		62f:519	
2		D12FST	QD2LA FIRST SAMPLE	First sample position	62f:520	
		D12LST	QD2LA LAST SAMPLE	Last sample position	62f:521	
		D12MPH	BPM MEM POINTER	QD Memory pointer	62f:348	
	0	D12BPH	QD2LA AVERAG ONOFF	Calc'd average for M1-S2	62f:522	ON/OFF AVG
	1	D12BPV	QD2LA AVERAG VERTI	Calc'd average for M1-S2	62f:523	
	2	D13BPH	QD2LA AVERAG HORIZ		62f:524	
	3	D13BPV	QD2LA AVERAG VERTI		62f:525	
	0	D12HSG	QD2LA SIGMA ONOFF		62f:526	ON/OFF SIGMA
	1	D12VSG	QD2LA SIGMA VERTIC		62f:527	
	2	D13HSG	QD2LA SIGMA HORIZO		62f:528	
	3	D13VSG	QD2LA SIGMA VERTIC		62f:529	
3		D21FST	QD3LA FIRST SAMPLE	First sample position	62f:530	
		D21LST	QD3LA LAST SAMPLE	Last sample position	62f:531	
		D21MPH	BPM MEM POINTER	QD Memory pointer	62f:34e	
	0	D21BPH	QD3LA AVERAG ONOFF	Calc'd average for M2-S1	62f:532	ON/OFF AVG
	1	D22BPV	QD3LA AVERAG VERTI	Calc'd average for M2-S2	62f:533	
	2	D23BPH	QD3LA AVERAG HORIZ		62f:534	
	3	D31BPH	QD3LA AVERAG HORIZ		62f:535	
	0	D21HSG	QD3LA SIGMA ONOFF		62f:536	ON/OFF SIGMA
	1	D22VSG	QD3LA SIGMA VERTIC		62f:537	
	2	D23HSG	QD3LA SIGMA HORIZO		62f:538	

	1	D22VSG	QD3LA SIGMA VERTIC		62f:537	
	2	D23HSG	QD3LA SIGMA HORIZO		62f:538	
	3	D31VSG	QD3LA SIGMA HORIZO		62f:539	
4		D32FST	QD4LA FIRST SAMPLE	First sample position	62f:540	
		D32LST	QD4LA LAST SAMPLE	Last sample position	62f:541	
		D32MPH	BPM MEM POINTER	QD Memory pointer	62f:358	
	0	D32BPV	QD4LA AVERAG ONOFF	Calc'd average for M3-S2	62f:542	ON/OFF AVG
	1	D33BPH	QD4LA AVERAG HORIZ	Calc'd average for M3-S3	62f:543	
	2	D34BPV	QD4LA AVERAG VERTI		62f:544	
	3	D41BPH	QD4LA AVERAG HORIZ		62f:545	
	0	D32VSG	QD4LA SIGMA ONOFF		62f:546	ON/OFF SIGMA
	1	D33HSG	QD4LA SIGMA HORIZO		62f:547	
	2	D34VSG	QD4LA SIGMA VERTIC		62f:548	
	3	D41HSG	QD4LA SIGMA HORIZO		62f:549	
5		D42FST	QD5LA FIRST SAMPLE	First sample position	62f:550	
		D42LST	QD5LA LAST SAMPLE	Last sample position	62f:551	
		D42MPH	BPM MEM POINTER	QD Memory pointer	62f:360	
	0	D42BPV	QD5LA AVERAG ONOFF	Calc'd average for M4-S2	62f:552	ON/OFF AVG
	1	D43BPH	QD5LA AVERAG HORIZ	Calc'd average for M4-S3	62f:553	
	2	D44BPV	QD5LA AVERAG VERTI		62f:554	
	3	D51BPH	QD5LA AVERAG HORIZ		62f:555	
	0	D42VSG	QD5LA SIGMA ONOFF		62f:556	ON/OFF SIGMA
	1	D43HSG	QD5LA SIGMA HORIZO		62f:557	
	2	D44VSG	QD5LA SIGMA VERTIC		62f:558	
	3	D51HSG	QD5LA SIGMA HORIZO		62f:559	
6		D52FST	QD6LA FIRST SAMPLE	First sample position	62f:560	
		D52LST	QD6LA LAST SAMPLE	Last sample position	62f:561	
		D52MPH	BPM MEM POINTER	QD Memory pointer	62f:368	
	0	D52BPV	QD6LA AVERAG ONOFF	Calc'd average for M5-S2	62f:562	ON/OFF AVG
	1	D53BPH	QD6LA AVERAG HORIZ	Calc'd average for M5-S3	62f:563	
	2	D54BPV	QD6LA AVERAG VERTI		62f:564	
	3	D61BPH	QD6LA AVERAG HORIZ		62f:565	
	0	D52VSG	QD6LA SIGMA ONOFF		62f:566	ON/OFF SIGMA
	1	D53HSG	QD6LA SIGMA HORIZO		62f:567	
	2	D54VSG	QD6LA SIGMA VERTIC		62f:568	
	3	D61HSG	QD6LA SIGMA HORIZO		62f:569	
7		D62FST	QD7LA FIRST SAMPLE	First sample position	62f:570	
		D62LST	QD7LA LAST SAMPLE	Last sample position	62f:571	
		D62MPH	BPM MEM POINTER	QD Memory pointer	62f:370	
	0	D62BPV	QD7LA AVERAG ONOFF	Calc'd average for M6-S2	62f:572	ON/OFF AVG
	1	D63BPH	QD7LA AVERAG HORIZ	Calc'd average for M6-S3	62f:573	
	2	D64BPV	QD7LA AVERAG VERTI		62f:574	
	3	D71BPH	QD7LA AVERAG HORIZ		62f:575	
	0	D62VSG	QD7LA SIGMA ONOFF		62f:576	ON/OFF SIGMA
	1	D63HSG	QD7LA SIGMA HORIZO		62f:577	
	2	D64VSG	QD7LA SIGMA VERTIC		62f:578	
	3	D71HSG	QD7LA SIGMA HORIZO		62f:579	
8		D72FST	QD8LA FIRST SAMPLE	First sample position	62f:580	
		D72LST	QD8LA LAST SAMPLE	Last sample position	62f:581	

8		D72FST	QD8LA FIRST SAMPLE	First sample position	62f:580	
		D72LST	QD8LA LAST SAMPLE	Last sample position	62f:581	
		D72MPH	BPM MEM POINTER	QD Memory pointer	62f:378	
	0	D72BPH	QD8LA AVERAG ONOFF	Calc'd average for M7-S2	62f:582	ON/OFF AVG
	1	D72BPV	QD8LA AVERAG VERTI	Calc'd average for M7-S2	62f:583	
	2	D73BPH	QD8LA AVERAG HORIZ		62f:584	
	3	D73BPV	QD8LA AVERAG VERTI		62f:585	
	0	D72HSG	QD8LA SIGMA ONOFF		62f:586	ON/OFF SIGMA
	1	D72VSG	QD8LA SIGMA VERTIC		62f:587	
	2	D73HSG	QD8LA SIGMA HORIZO		62f:588	
	3	D73VSG	QD8LA SIGMA VERTIC		62f:589	
9		D74FST	QD9LA FIRST SAMPLE	First sample position	62f:590	
		D74LST	QD9LA LAST SAMPLE	Last sample position	62f:591	
		D74MPH	BPM MEM POINTER	QD Memory pointer	62f:37c	
	0	D74BPH	QD9LA AVERAG ONOFF	Calc'd average for M7-S4	62f:592	ON/OFF AVG
	1	D74BPV	QD9LA AVERAG VERTI	Calc'd average for M7-S4	62f:593	
	2	D75BPH	QD9LA AVERAG HORIZ		62f:594	
	3	D75BPV	QD9LA AVERAG VERTI		62f:595	
	0	D74HSG	QD9LA SIGMA ONOFF		62f:596	ON/OFF SIGMA
	1	D74VSG	QD9LA SIGMA VERTIC		62f:597	
	2	D75HSG	QD9LA SIGMA HORIZO		62f:598	
	3	D75VSG	QD9LA SIGMA VERTIC		62f:599	
controls/memos/BPMControls.table						

Table 2., Generic Description of the BPM/LA Parameters	
Database Name	Description
L:DmnBPH	Horizontal beam position average position
L:DmnBPV	Vertical beam position average position
L:DmnBIH/V	Intensity signal (through SRM)
L:DmnMPH/V	Memory pointer to QD; used by BPMQ and Macintosh
L:DmnFST	Sample on which to begin the average/sigma calc
L:DmnLST	Sample on which to last the average/sigma calc
L:DmnHSG	Results of the sigma calculation, horizontal plane
L:DmnVSG	Results of the sigma calculation, vertical plane
L:DqQDRn	Pseudo-channels to setup QD on reset
controls/memos/BPMGeneric.table	